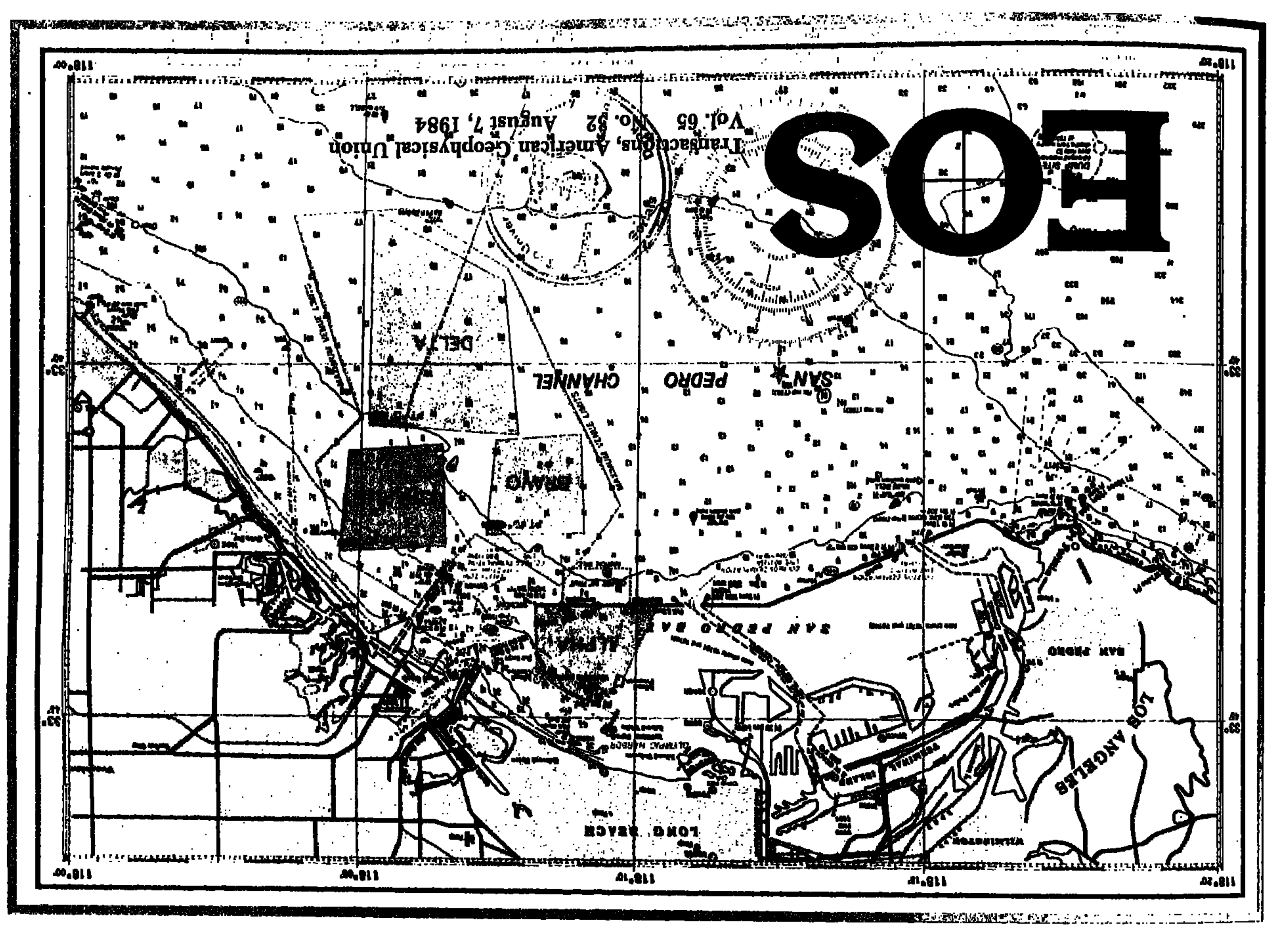
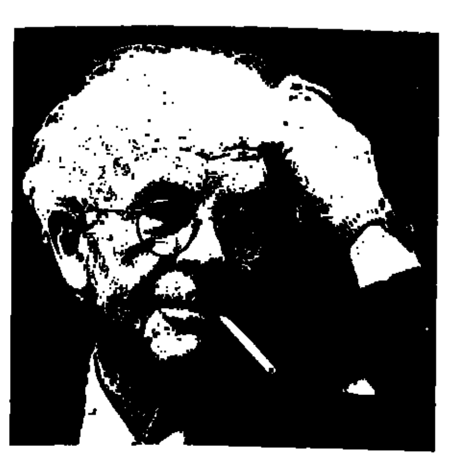


Eos, Transactions, American Geophysical Union Vol. 65, No. 32, Pages 465–472 August 7, 1984

Particles and Fields—Interplanetary Space

Particles and Fields—Ionosphere

Scott E. Forbush 1904–1984



Scott E. Forbush, a pioneer in cosmic ray research, was the quintessential geophysicist's geophysicist. Until, on the eve of his 80th birthday, he succumbed to pneumonia, he maintained an abiding interest in the continued reliable operation of the three remaining cosmic ray ionization chambers of the worldwide network that he had set up in the mid 1930's. No one could have predicted, when the first instrument at Cheltenham, Md. commenced operation in 1936, that Forbush was destined to discover most of the important multifarious time variations of cosmic rays that were accessible to his classic detectors: the first-generation instruments that were similar in principle to those with which a mysterious penetrating radiation, probably from an extraterrestrial source, had been discovered by Victor Hess in a series of manned balloon flights in 1912. The time scales of the effects which Forbush studied ranged from minutes to decades.

How did Scott Forbush get into a field in which he was to occupy an absolutely unique niche, assiduously pursuing a single unswerving goal, to derive from continuous observations with ionization chambers all of the statistically significant information that the data were capable of revealing? As he told it, "... around 1926 I wasn't overly in love with my job at the National Bureau of Standards, and I was offered the possibility of going to Peru to a Geomagnetic Observatory which was operated at Huancayo by the Department of Terrestrial Magnetism (DTM) of the Carnegie Institution of Washington (CIW)".

In 1932, a committee set up by the CIW to consider a request by R. A. Millikan and A. H. Compton (who didn't agree very often) concluded that it would indeed be useful to have a network of cosmic ray detectors situated at "convenient places." These convenient places would be magnetic observatories because they already existed, and so the first detector in the network was installed at Cheltenham Magnetic Observatory, Md., in 1935. It is still in operation (at Fredericksburg). Forbush was put in charge of this program. The instrument (Figure 1) was called a Compton-Bennett meter or, alternatively, a model C meter. What you got, then and now, is a trace on a photographic bromide paper representing the combination of the ionization currents caused by the cosmic rays and any local radioactive material.

Forbush and one assistant laboriously scaled by hand and reduced all of these records which, of course, included barometric pressure readings. Subsequently, volumes containing the final results were sent to many workers throughout the world.

Forbush, by his detailed analyses of the many different cosmic ray intensity time variations, stimulated others to make more experimental observations and to propose theoretical explanations for these phenomena. The cosmic ray time variations cover a very large dynamic range. The shortest occurs during the onset of ground level enhancements (GLE's) associated with solar flares. There is a diurnal variation arising from the earth's rotation. There are transient events called Forbush Decreases, which are of somewhat longer duration. There are 27-day recurrences related to the rotation of the sun. There is an annual variation. There's a solar activity cycle effect (11 years), and a solar magnetic cycle effect (22 years). Each one of these was discovered (or put on a firm footing) by Scott Forbush in a one-man operation with the help of one dedicated assistant, Isabelle Lange until 1957, then Lisellote Beach until her retirement in 1975.

Forbush was very much influenced by Julius Bartels, who was an associate at the Carnegie Institution of Washington during the period 1931–1940. Actually, Forbush was somewhat of a professional statistician, who "... read on buses every book on the subject that I could get my hands on." Thus, he was able to benefit very greatly from Bartels' presence there, as exemplified in an early paper [*Forbush*, 1937*a*]: "The adequate characterization of the diurnal variation in any geophysical phenomenon requires not simply a knowledge of its average value, but also a full knowledge of its variability. The latter, in general, is made up of an irregular (or random) part and a systematic part such, for example, as a systematic variation with season in the amplitude (or phase) of the diurnal variation. These facts, together with the methods of analysis used in this discussion, have been set forth clearly in numerous papers by J. Bartels, who, as a research associate for the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, has made important applications to problems in terrestrial magnetism." This profound respect for and admiration of Bartels is evident throughout all of his writings, which frequently refer to Bartels. What Forbush, in his characteristic self-effacing modesty always claimed he was doing, was merely extending some procedures for which Bartels had (perhaps) given the basis but hadn't carried out to its full extent.

With his first 233 days of ionization chamber observations, Forbush did what was then a very elaborate statistical analysis, and found that the controversial diurnal variation was, indeed, real. In his paper on this subject [*Forbush*, 1937*a*] he stated, "To summarize the analysis of the data for Cheltenham demonstrates the existence of a physically real 24-hour wave in apparent cosmic ray intensity, which does not appear to be due to systematic instrumental effects but which may be due, in part at least, to variations in local radiation." He eked out of these data an exceedingly small vector which is the order of half a percent, and for the first time the probability that it is a real effect was rigorously and correctly evaluated. The now well understood semi-diurnal variation is smaller than the first harmonic and at this point Forbush had to decide its presence could not be established within the statistics of the available data.

Another phenomenon, that had been claimed by *Compton and Getting* [1935] on the basis of their analysis of ionization chamber data, was the effect of the motion of the galaxy: If there is a uniform distribution of cosmic rays coming from all directions, then the rotational speed of the earth and the galaxy should produce a net anisotropy in sidereal time. *Forbush* [1937*b*] also investigated this matter, and his conclusion was "Compton and Getting found from the data of Hess and Steinmaurer that the amplitude of the apparent 24-hour sidereal wave was nearly 10 times their estimate of its probable error. Their exact procedure in obtaining this estimate was not given." If there was anything that made Soctt Forbush angry (to put it mildly), it was failure to describe the statistical procedure that was used to obtain the claimed results. Quoting further, "Estimates of the probable errors in geophysical data are especially misleading." In this regard, Forbush then stressed a very important point. "If based on the departures of observed points from a fitted wave, they are invariably too small unless the departures for successive points are statistically independent. Tests on cosmic ray data from Cheltenham indicate that such departures are not independent. Our conclusions regarding the reality of the 24-hour sidereal wave are based on a method of analysis which takes account of this. It is surely one of the most constructive recent developments in physics that such powerful tools have been evolved for evaluating the real or illusory nature of such interesting periodicities."

The first two observations of solar cosmic rays were made by Forbush in 1942 (Figure 2). Because of his cautious approach, Forbush waited for still another GLE to occur before publishing his discovery in a paper [*Forbush*, 1946] characteristically titled most cautiously. He concluded, "These considerations suggest the rather striking possibility that the three unusual increases in cosmic ray intensity may have been caused by charged particles actually being emitted by the sun with sufficient energy to reach the earth at geomagnetic latitude 48° but not at the equator."

In a later paper [*Forbush, et al.*, 1950], there is a conclusion, more or less in between the lines, from observations of a GLE for the first time on top of a mountain, that the spectrum of relativistic solar cosmic rays is very steep, indeed, and that what one is seeing is rather low-energy nucleons coming from the sun in this case. Actually, Forbush was very lucky because GLE's of sufficient magnitude to be detected with ionization chambers have not occurred since 1956.

The Forbush decrease [*Forbush*, 1937*c*] is the only discovery which carries his name (Figure 3). By comparing data from the worldwide network of stations that he had established, he was able to show for the first time that certain changes in cosmic ray intensity were worldwide [*Forbush*, 1938]. It was very common and natural in those days to associate those sudden decreases with changes in the geomagnetic cut off due to some ring current, for example. It was also natural if you were working at the Department of Terrestrial Magnetism, that you would think of this, and other effects—such as 27-day recurrences [*Forbush*, 1940], for example—as attributable in some way to geomagnetic field variations. So he found that there were events in which the cosmic ray intensity seemed to more or less track the horizontal intensity of the geomagnetic field. But then he found cases of a large geomagnetic storm during which the cosmic ray intensity didn't change at all [*Forbush*, 1955]. That remained a mystery for quite a while. An interesting point is brought out here. Relating the geomagnetic activity with the level of cosmic ray intensity *Forbush* [1938] stated, "Since the period of minimum values for the departures in cosmic ray intensity in this figure agrees roughly with that of maximum magnetic activity, and since we have also indicated the existence of a 27-day wave, probably quasi-persistent in cosmic ray intensity, it would not be unexpected to find, when adequate data are available, the 11-year cycle of sunspot activity reflected in cosmic ray intensity." That was really looking ahead! Forbush also noticed that during solar minimum, the variations in the intensity were very much less than when the sun was most active.

The last of the Forbush discoveries was the 22-year wave in the diurnal variation (Figure 4) [*Forbush*, 1967, 1969, 1981; *Duggal et al.*, 1970*a, b*]. Although the solar cycle (11-year) variation was universally accepted, his claims for a 22-year wave were at first rejected by some members of the cosmic ray community but have since been vindicated.

The superimposed epoch technique was introduced by Sir Charles Chree (1913), and a medal bearing his name was established by the British Institute of Physics and the Physical Society. Forbush received this Chree Medal in 1961. He later remarked that he thought he probably got it because he "... was mad at Chree." The reason he was mad at Chree was that when Chree proposed this new way of doing things, he never told you how to do the statistics. It is very, very tricky, and the solution of this long-standing problem constituted Forbush's final contribution [*Forbush et al.*, 1982, 1983].

In 1966, Forbush received the American Geophysical Union's John A. Fleming award, the citation for which noted that his findings came through "... intricate development of statistical methods and the most erudite analysis of data."

Especially in his first detailed paper on the "Variation with a Period of Two Solar Cycles in the Cosmic-Ray Diurnal Anisotropy [*Forbush*, 1969], he developed an elegant albeit arcane analytical procedure and notation that somehow tended to conceal the significance of the results, the full understanding of which required great patience on the part of the reader. On the other hand, he was as demanding of others as he was of himself. He insisted that people should publish their data so that others could analyze them with their own procedures. He did not assiduously follow the literature because he felt that the cost is high. His disdain for laziness and sloppiness as he perceived it led him to ask "What can you believe?"

Scott Forbush was chairman of the Cosmic Ray Committee for the International Geophysical Year. He also served on the Visiting Committee of the Bartol Research Foundation, where he was appointed Distinguished Professor upon his retirement from D.T.M. in 1969. Forbush spent two happy periods at other institutions, one in 1959 at the University of Iowa, another at Imperial College, London, in 1968. While pursuing his research in Peru, he was named Honorary Professor and presented an award by the Universidad de San Marco, Lima. He was elected to the National Academy of Sciences in 1962, and was a fellow of AGU, American Association for the Advancement of Science, and APS.

I am proud to have been coauthor of a number of papers with Scott Forbush and Shakti Duggal, whose untimely death at the age of 50 in 1982, created the first gap in our long-term collaboration. The last two papers [*Forbush et al.*, 1982, 1983] brought to the ultimate limit the quantitative implications of Scott's insight more than 40 years earlier. Scott had planned to spend a period at Bartol in March 1984, when he was struck down by a fatal illness. He had long enjoyed good health (few knew that he suffered from diabetes) and was an avid jogger many years be-

Article (cont. on p. 474)

Fig. 1. Compton-Bennett meter, also known as model C meter, utilized in the worldwide network of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, set up by Scott E. Forbush.

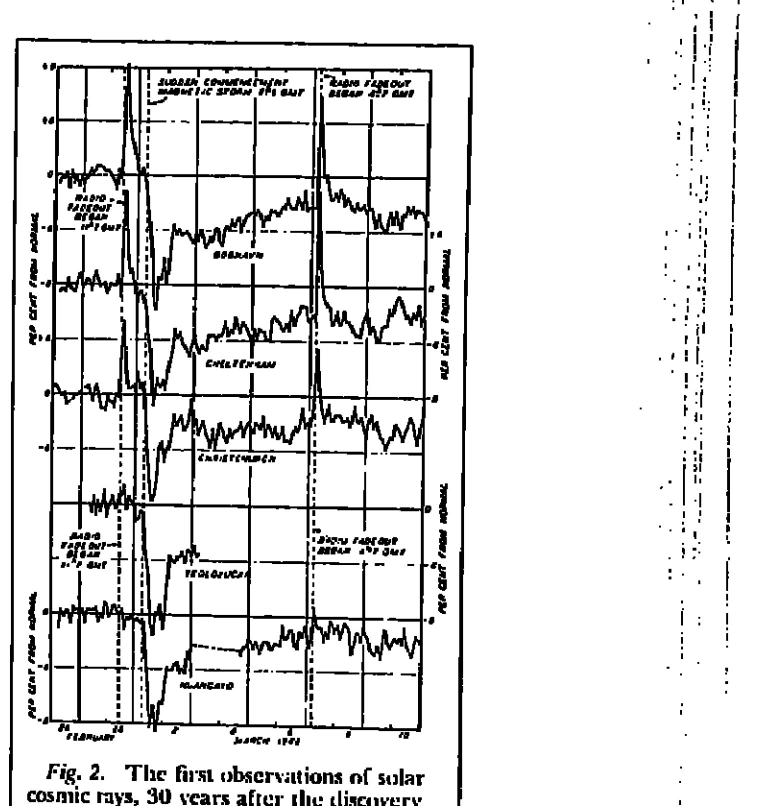


Fig. 2. The first observations of solar cosmic rays, 30 years after the discovery of galactic cosmic rays by Victor Hess [*Forbush*, 1942].

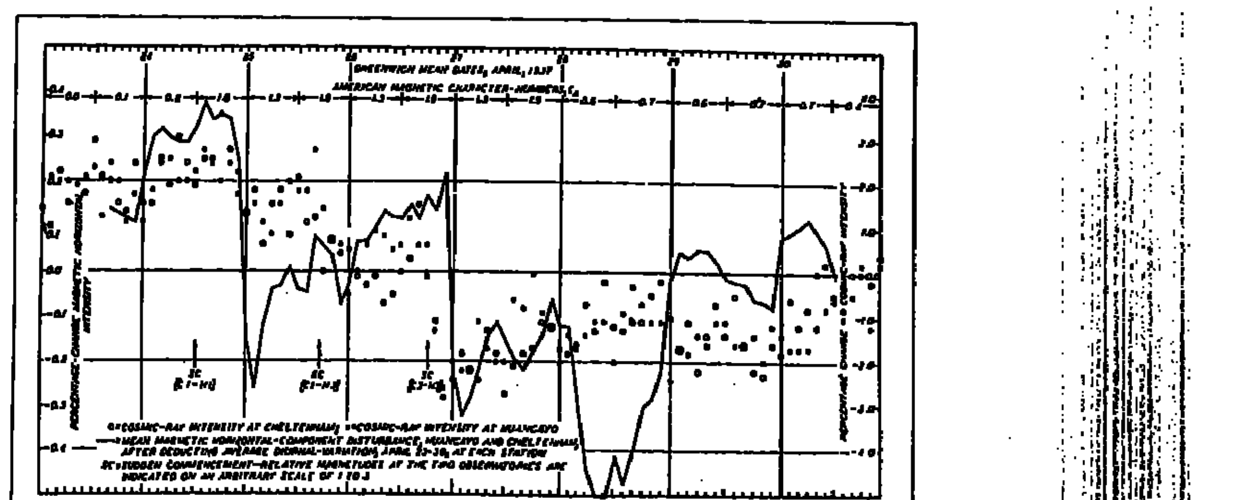


Fig. 3. The discovery of the Forbush Decrease in 1937 [*Forbush*, 1937*c*].

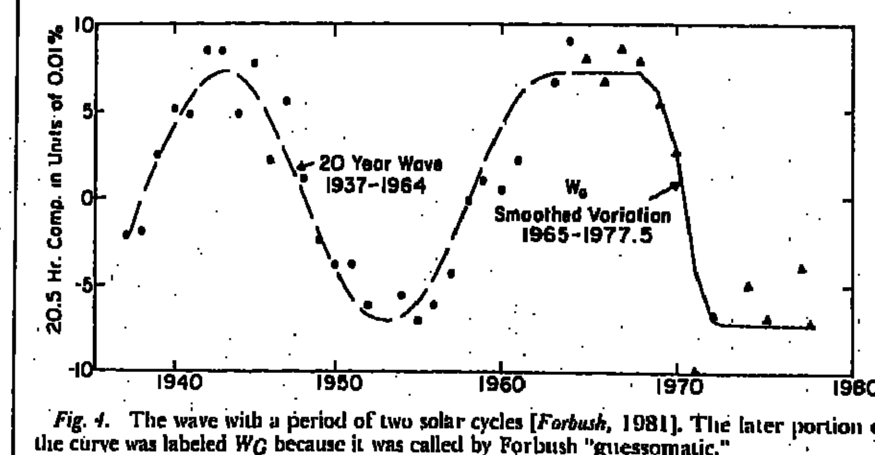


Fig. 4. The wave with a period of two solar cycles [*Forbush*, 1981]. The later portion of the curve was labeled W_G because it was called by Forbush "guessomatic."

Article *(cont. from p. 473)*

fore this form of exercise became popular. He was incensed when a younger person offered to carry his bag to his room in a hotel at Banff during the 10th International Cosmic Ray Conference (ICRC) in Calgary in 1967. He seldom missed these biennial meetings, but his failing sight precluded attending the most recent ICRC in India. He overcame this frustrating handicap by using a magnifying glass and by writing in very large letters.

Preparation of the last manuscripts was exceedingly difficult, for Forbush was meticulous about the format and even the choice of words. The statistical aspects of all cosmic ray papers emanating from Bartol were always examined critically by Forbush, and when the Forbush Imprimatur was accorded a manuscript, we knew that we were right.

It is striking that he never succumbed to the "publish or perish" syndrome. His publication list comprises somewhat less than two dozen papers over a period of 46 years (a significant number appeared after his retirement). A review paper [*Forbush, 1966*], covering 30 years of work to that time, contains 12 Forbush references. But it is an undeniable fact that every single one of Scott Forbush's papers was a landmark result that will remain indelibly etched in the annals of science.

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This tribute was written by Martin A. Pomerantz, *Bartol Research Foundation of the Franklin Institute, University of Delaware, Newark, DE 19716.*

News

Valles Caldera Research Opportunity

Potential opportunities for research will be available after the completion this summer of a 650-m, 7.6-cm-diameter scientific core taken from the southern ring-fracture zone of Valles Caldera, New Mexico. (See Figure 1.)

The Valles Caldera coring effort stems from three primary objectives: to study the hydrogeochemistry of a subsurface geothermal outflow zone of the caldera near the source of convective upflow; to obtain structural and stratigraphic information from intracaldera rock formations under the southern ring-fracture zone; and to obtain continuous core (6.25 cm) samples through the youngest volcanic unit in Valles Caldera, the Banco Bonito obsidian (approximately 0.1 to 0.05 million years).

The completed corehole will be made available for scientific observations for 5 years. The corehole will be spudded on the Banco Bonito obsidian flow and penetrate intracaldera rhyolites and tuffs, caldera fill deposits, and, possibly, flanking units of pre-caldera volcanics and Paleozoic marine rocks. The corehole site lies at the intersection of the caldera ring fracture/collapse zone and the pre-caldera Jemez fault zone. The top of the hydrothermal outflow plume is thought to lie at a depth of 500 m and have a temperature between 120° and 150°C. The source of hydrothermal fluids lies a scant 4 km northeast of the coring site, beneath the caldera resurgent dome, where hydrothermal fluids as hot as 300°C have been encountered.

The coring effort, scheduled to have begun as *Eos* went to press, is sponsored by the Continental Scientific Drilling Program (thermal regimes), which seeks to answer fundamental scientific questions about magma and hydrothermal systems using coreholes and wells. The corehole planned for this summer at Valles Caldera results from funding of a collaborative proposal between Sandia, Lawrence Berkeley, Lawrence Livermore, and Los Alamos National laboratories. The collaboration includes other shallow coreholes and wells being drilled at Long Valley Caldera and the Salton Sea geothermal field.

Los Alamos is coordinating activities for the project, but research proposals should be sent to appropriate federal and state funding agencies. Potential investigators who need more information or who wish to be kept informed of developments should send their mailing addresses and telephone numbers to Fraser Goff, John Rowley, or Bob Charles at Los Alamos National Laboratory, Los Alamos, NM 87545.

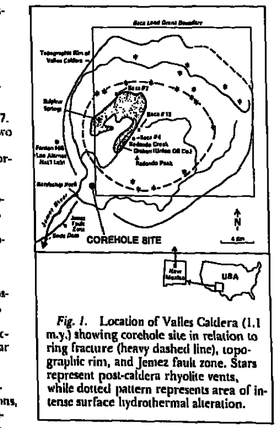

Fig. 1. Location of Valles Caldera (1.1 m.y.) showing corehole site in relation to ring fracture (heavy dashed line), topographic rim, and Jemez fault zone. Stars represent post-caldera rhyolite vents, while dotted pattern represents area of intense surface hydrothermal alteration.

NSF Atmospheric Science Review

The National Science Foundation's (NSF) Division of Atmospheric Sciences (ATM) is doing extremely well, according to a recently completed review of two of its grant programs by an outside advisory committee. As a major part of NSF's activities in the physical sciences, ATM is responsible for providing more than $89.3 million annually in support of principal university research, the National Center for Atmospheric Research (NCAR), and the Upper Atmosphere Facilities radar network.

The Advisory Committee for Atmospheric Sciences (ACAS) has both external and internal functions. The committee addresses several internal objectives including provision of oversight of program management required by NSF of individual programs within the division; provision of guidance on both short- and long-range planning including advice on priorities of scientific needs and opportunities; and advice on the impact of ATM research support programs on the atmospheric sciences community.

The external activities of ACAS involve two efforts. The committee attempts to advocate the special needs of the atmospheric sciences community and the program of ATM within the broad scientific community. The second effort is to provide a mechanism for two-way communication between NSF and the scientific community by informing the atmospheric sciences community about ATM achievements and needs and, in turn, transmitting the needs of the community to ATM. Current committee members include Stanley A. Changnon, Illinois State Water Survey, as chairman; Robert A. Houze, University of Washington; Michael Kelley, Cornell University; James F. Kimpel, University of Oklahoma; Margaret Rivelson, University of California, Los Angeles; Mukul Kundu, University of Maryland; John E. Kutzbach, University of Wisconsin; Jennifer Logan, Harvard University; Volker Mohnen, State University of New York, Albany; Frederick Sanders, Massachusetts Institute of Technology; Jesse J. Stephens, Florida State University; and Max Suarez, NASA, Goddard Laboratory for Atmospheric Sciences. The Advisory Committee meets twice yearly, normally in the spring and the fall. The most recent review of ATM programs occurred on October 26–28, 1983, in Washington, D.C.

The Atmospheric Sciences Division of NSF is directed by Eugene W. Bierly, who is assisted by section heads Richard S. Greenfield and Giorgio Tesi. There is a staff of 22 professionals. Approximately $40 million dollars of the total FY84 budget are directed to NCAR and $3.8 to the Upper Atmosphere Facilities Program. The other $45.5 million went to support grants, most of which went to universities or not for profit institutions.

At the October meeeting of ACS, the committee provided intensive review of two programs, the Solar Terrestrial program and the Meteorology program. Both programs were complimented highly for the outstanding leadership of their program managers, Dennis S. Peacock of Solar Terrestrial and Ronald C. Taylor of Meteorology. Their broad knowledge of the areas for which they are responsible and of related areas of atmospheric sciences have brought diverse funds and unique solutions to funding of innovative research. Important to all such programs of NSF is good balance between subdisciplines in each program. Both program directors divided the available resources wisely. Encouragement of new research thrusts was particularly notable in both program efforts. Both programs have reflected awareness of trends in their disciplines and have made appropriate adjustments, according to ACAS. For example, in the Solar Terrestrial program there is a clear awareness that plasma physics is now a unifying scientific discipline within the solar terrestrial community.

During the October meeting, the committee also was briefed on UCAR-NCAR relations with presentations by Clifford Murino, the new president of UCAR, and Wilmot Hess, director, NCAR. The role of supercomputers and NSF's evolving position on these were reviewed and discussed.

At the conclusion of the meeting, ACAS developed a series of recommendations and a resolution for the Atmospheric Sciences Division of NSF. The committee (1) recommended ways to ensure awareness of cross cutting research issues in the Aeronomy and the Solar Terrestrial programs; (2) asked for further information on how programs of ATM and NCAR are planned and integrated; (3) stated a need for information about how budget allocations at NCAR impact the university grants budget and the ATM program initiatives; (4) recommended an aggressive approach by ATM to the new thrust of NSF into science education; and (5) expressed concern over the balance of funding between facilities and the educational development of graduate students.

A specific resolution was presented to NSF by ACAS enforcing the October 1983 joint resolution of the (NCAR) Research Aviation and Field Observing Facility Advisory Panels calling for reversal of the funding trend for the NCAR Atmospheric Technology Division. The ACAS noted that at a time of active planning for several atmospheric science field observing programs, it was unthinkable that NCAR responsibility to provide observational tools not be met while other NCAR divisions are enhanced.

As noted previously, one of the objectives of ACAS is to inform the scientific community about the status of the Divison of Atmospheric Sciences of NSF. An important element of interaction between scientists and the ATM program directors relates to the discussion on proposals. Program directors highly recommend to any potential principal investigators (PI) that they contact the program director, either by telephone or by a letter, to discuss their ideas before prepating a full proposal. Much useful advice can be transmitted to the potential PI's through these discussions. Advice relating to when and how to submit, content of ideas, and many other particulars that will ease the preparation of proposals can be achieved by these informal approaches.

This news item was contributed by Stanley A. Changnon, *Illinois State Water Survey, Champaign, Ill.*

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To take advantage of this offer, AGU members should send subscription orders, remittances, and a statement indicating membership status to AIP, 335 East 45th Street, New York, NY 10017.—*BTR*

NACOA: Burford Steps Down

Anne M. Burford, who had been appointed early last month by President Ronald Reagan to chair the National Advisory Committee on Oceans and Atmosphere (NACOA), asked the president on August 1 to withdraw her appointment. John A. Knauss, of the University of Rhode Island's Graduate School of Oceanography, will retain his position as NACOA chairman. He has been on the committee for 6 years.

President Reagan agreed to her request the afternoon before Burford was to chair her first meeting. The new NACOA members (*Eos*, July 17, 1984, p. 442) were sworn in on August 2, although the meeting was postponed until September 20, a NACOA official told *Eos*.

The House of Representatives and the Senate each passed non-binding resolutions that expressed disapproval over her appointment. The House resolution (H.Res. 555) was introduced on July 25 by James Scheuer (D-N.Y.), chairman of a subcommittee of the House Committee on Science and Technology; it passed (by a vote of 363 to 51) on July 31. Sen. Edward Kennedy (D-Mass.) introduced an amendment to the appropriations bill for the Department of Treasury (amendment 3380 to H.R. 5798) that urged President Reagan to withdraw Burford's appointment. The bill, including the amendment, passed July 24 by a vote of 74 to 19.

In addition, Sen. Ernest F. Hollings (D-S.C.) introduced a bill (S. 2875) on July 26 that would establish qualifications for individuals appointed to NACOA and that would authorize appropriations for fiscal year 1985. The bill has been referred to the Senate Commerce, Science, and Transportation Committee. Because Congress has just adjourned (for the Republican National Convention and the Labor Day district work period) and will be in session for less than a month before the November elections, it is unlikely that the bill will pass before the 98th Congress ends. —*BTR*

Upcoming Hearings in Congress

The following conference committee has been tentatively announced for the coming weeks by the Senate and House of Representatives. For additional information, all offices on Capitol Hill may be reached by telephoning 202-224-3121. For guidelines on contacting a member of Congress, see *AGU's Guide to Legislative Information and Contacts* (*Eos*, April 17, 1984, p. 159).

TBA: Conference on the **Export Administration Act** reauthorization (S. 979), including information flow and the impact on science (*Eos*, June 26, 1984, p. 412). The bill was introduced by John Heinz (R-Pa.). Time and room to be announced (note: conference scheduled for July 31 was canceled).

EOS

Transactions, American Geophysical Union

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Cover. Longitudinal triangular ripple (LTR) and other sedimentary bedforms are visible in this photograph taken at a depth of 4800 m at the HEBBLE (High Energy Benthic Boundary Layer experiment) site. Of the many commonly observed bedforms, the LTR represents one of the most intriguing, since these ripples are aligned with the mean flow unlike beach ripples, which are aligned normal to the water motion. One of these LTR's was fortuitously sampled in a box core, from which it was learned through radioanalysis that the sampled ripple was quite young and of depositional nature. The LTR's appear to be quite ubiquitous in the high energy benthic environments and are evidence of streamwise vorticity (helical motions). The quantitative aspects of their generation are not fully understood. This photograph was taken from a camera mounted on a tripod carrying a suite of flow measuring instruments, including the Benthic Acoustic Stress Sensor, the Laser Doppler Velocimeter and the Acoustic Backscatter System. Note a string tied to the NE wire indicates flow direction at the time of the photograph to be parallel to the LTR. The photograph was taken from 2 m above bottom looking 30° from vertical, using a 32 mm lens (in water). (Photograph courtesy of Y. C. Agrawal, F. R. Hess, and A. J. Williams III, Woods Hole Oceanographic Institution, Woods Hole, Mass.)

Books

Man, A Geomorphological Agent: An Introduction to Anthropogic Geomorphology

Dov Nir, D. Reidel, Hingham, Mass., 165 pp., year published, $45.50.

Reviewed by G. Richard Whittecar

Many human activities alter surrounding landforms. In *Man, A Geomorphological Agent*,, Dov Nir systematically evaluates the role of people as an integral portion of the total geomorphological system. His expressed purpose is to develop the theme of "anthropic geomorphology" and to elucidate its position in the broader field of cultural geography. In this task Nir is generally successful, but the overall usefulness of the resulting book is limited.

Topics selected for discussion cover a large spectrum. The geomorphology of agriculture, pasturing, mining, transportation, and settlement plus the interactions of people with forests, rivers, and shorelines are each covered in separate chapters. Nir uses an introduction to explain the history of anthropic geomorphology and concludes with a discussion about conceptual models and methods of research. A two-page appendix describes the geomorphic effects of warfare.

Any single volume which thoroughly discussed the processes by which people change the landscape would be very large. Instead of producing such a tome, the author uses a relatively short book to provide a synopsis of research related to anthropic geomorphology. The examples cited come from throughout the English-speaking world, draw upon geologic, geographic, archeologic, and engineering analyses, and are well organized and integrated into a coherent exposition. Throughout the book, however, the amount of discussion given to any single topic is very brief, ranging from three sentences to two pages. In that space the author focuses upon the effects of human activities rather than upon the causative processes. Remedial and preventative actions are mentioned for many situations.

From my perspective as a geomorphologist, the author's main contribution is his thoughtful attempt to generate a quantitative estimate of the degree to which human activity may affect surficial processes. Using the percent urban population as a measure of possible human disturbance of the land and the illiteracy rate to indicate the lack of environmental awareness, Nir calculates an index of potential anthropic geomorphology for 87 countries.

The text is not one, however, that I would advise using as a class text without large numbers of supplementary readings. Because a great many topics are covered in the book, the selection of papers cited is usually cursory. Furthermore, the lack of emphasis upon geomorphic processes and the omission of certain well-known topics also lessens the book's usefulness. For example, discussions of the role of groundwater sapping in the formation of gullies, the problems of deflation on regraded shoulders of roadways in semiarid lands, and the degradation of permafrost due to deforestation, settlements, and agriculture are not included.

Although the type is printed clearly, many of the illustrations are poorly reproduced. Most of the line drawings are borrowed, and many were not copied well. Several of the original photographs are only marginally adequate because they are too dark, too grainy, or poorly composed. The cost of the book seems high in relation to its size.

In brief, geography and geology teachers probably will find only limited use for this text, even in advanced classes. Geomorphologists developing research topics outside of their primary field should check this book for interesting references and examples.

G. Richard Whittecar is with the Department of Geological Sciences, Old Dominion University, Norfolk, VA 23508.

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POSITIONS AVAILABLE

Geochemist. The University of California, Davis, Department of Geology, has an opening for a one year temporary faculty position for Fall 1984. Specific fields are open; however specialization in isotope and economic geochemistry are desirable. The Department has strong programs in paleobiology, paleoceanography, petrology, geophysics, and crust and mantle evolution. A Ph.D. is required. Responsibilities include graduate and undergraduate teaching and research in geochemistry.

Applicants should submit vita, statement of research and teaching interests, and the names of three references as soon as possible, as the position is for the Fall, 1984 quarter.

We anticipate that this position will be opened on a permanent, tenure track basis during the next academic year. A successful candidate for this temporary position can apply for the tenure track position. Inquiries and applications should be sent to Chair, Search Committee, Department of Geology, University of California, Davis, Davis, California 95616.

The University of California is an equal opportunity/affirmative action employer.

Geologists-Geophysicists/Institute for Geophysics, The University of Texas at Austin. The Institute for Geophysics at the University of Texas at Austin has openings for research staff, particularly in the areas of theoretical seismology and sea-going marine geology/geophysics. The Institute is located in Austin and operates closely with the Department of Geological Sciences of the University. It is a vigorous and growing group with interests in both land and marine geology/geophysics. Research facilities include a 198-foot ship equipped with multichannel and high resolution seismic reflection and OBS seismic refraction capabilities. A VAX 11/780 computer with DISCO software is available for data processing.

Applicants should hold a Ph.D. in geology, geophysics or other appropriate field and have demonstrated creativity in research. Senior and mid-career researchers as well as recent Ph.D.'s are encouraged to apply. Applications should be received by September 15, 1984. The salary is dependent upon qualifications. Please forward applications, curriculum vitae, names of at least three references, and other supporting materials to: Dr. A.E. Maxwell, Director, Institute for Geophysics, The University of Texas at Austin, P.O. Box 7456, Austin, TX 78712.

The University of Texas is an equal opportunity/affirmative action employer.

Geological Engineer (Search Reopened). The Department of Geology and Geological Engineering, at the University of Mississippi, has a tenure track position opening for a Geological Engineer; rank and salary open. Requirement: either a BS in Engineering (preferably geological or civil) from an Accreditation Board for Engineering and Technology or Canadian Accreditation Board accredited program and a PhD in Geoscience, or a BS in Geology and a PhD in either Geological or Civil Engineering. Work experience and PE registration preferred. Closing date: November 1, 1984. Send a resume and the names, addresses and phone numbers of three references to: Professor G. Brunton, Chairman, Department of Geology/Geological Engineering, University of Mississippi, University, MS 38677.

Equal Opportunity Employer.

Appointment in Research on Climatology and Air-Sea Interactions. A joint appointment is available at the Jet Propulsion Laboratory (JPL) and Scripps Institution of Oceanography (SIO) for research on climatology and air-sea interactions. At SIO the appointment will be as adjunct professor, the level depending upon qualifications and experience. At JPL, the appointment will be in the research staff with comparable rank. The appointee will have responsibilities at both institutions, including teaching and supervising graduate students at SIO. Applicants should have a strong background at the Ph.D. level in a relevant field, such as applied mathematics, physics, chemistry, meteorology, or physical oceanography. The successful applicant will have excellent research potential, the ability to interact effectively with JPL and SIO scientists, and the ability to advise JPL and NASA management on programs in this area. Compensation is negotiable. Inquiries may be made of either of the following: Dr. M.T. Chahine, Jet Propulsion Laboratory, 183-505, 4800 Oak Grove Drive, Pasadena, CA 91103 (telephone: 818-354-2433); or Professor R.C.J. Somerville, Scripps Institution of Oceanography, A-024, University of California, San Diego, La Jolla, CA 92093.

EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYERS.

Project Associate/Specialist: Electron Micro-Probe Lab, University of Wisconsin-Madison. Strong analytical background in quantitative EMP analysis and familiarity with computers is required. The Lab has a 5-spectrometer ARL SEMQ and a JEOLCO 50-A SEM. Duties will include instrument maintenance, instruction of students, development of procedures and analysis. Research will be encouraged. A MS or PhD is required in Earth Science, Chemistry, Physics or Engineering. Minimum salary will be $18,000/12 months with an MS. Send letter of application, transcripts, resume, and names and addresses of three references by September 15 to Dr. John W. Valley, Department of Geology & Geophysics, Weeks Hall, University of Wisconsin, Madison, WI 53706.

An equal opportunity employer.

University of Texas at Austin. The Department of Geological Sciences invites applications for a person to teach depositional systems and petroleum geology at the undergraduate and graduate levels and to conduct a vigorous research program, including the supervision of graduate students, in the area of the person's interest. The person must be willing to teach the above subjects to non-majors on occasion. The position requires the Ph.D. and is open to both tenure-seeking junior persons and senior-level persons. Availability by January 1985 is desirable. Applicants should submit a detailed resume, names and addresses of five references, and a statement of teaching and research interests by November 1, 1984 to Dr. Earle F. McBride, Department of Geological Sciences, University of Texas, Austin, Texas 78712. New Ph.D.-holders should also submit a copy of their dissertation abstract.

The University is an equal opportunity/affirmative action employer.

Stanford University/Plasma Physics, EM Waves, Space Physics. We are seeking a senior person who has demonstrated scientific, managerial, and leadership qualifications in one or more of the following disciplines: Space Plasma Physics, electromagnetic waves, and solar-terrestrial physics. We expect the successful candidate to have established an outstanding reputation documentable through professional writings or other evidence of personal technical creativity, letters of reference from recognized research leaders in the disciplines mentioned above, and/or awards and other recognition from appropriate professional societies.

It is expected that this individual will develop a research program in one of the disciplines given above working in coordination with ongoing programs within the STAR Laboratory and, possibly, with other activities within the Stanford Center for Space Science and Astrophysics. It is expected that this individual will have a strong background in experimental techniques, either in the laboratory or in the field, including the environment of space; experimental activities in either laboratory or space plasma physics would be regarded as good qualifications. However, close association with theoretical developments in plasma physics and/or electromagnetic theory will clearly be desired. It is also expected that the individual will have a demonstrated capability for securing federal or other research grant support, or be deemed by the selection committee of being capable of securing such funds.

It is anticipated that the person chosen will devote the major part of his or her time to research activities. However, there is an opportunity for participation in academic responsibilities of Electrical Engineering Department, including, when time permits, teaching graduate and undergraduate classes, serving on various committees of the department, School of Engineering, and the University. It is expected that the person chosen will participate actively in the training of graduate students.

The Chairman of the selection committee for this position is Professor Robert A. Helliwell, Professor of Electrical Engineering, Space, Telecommunications, and Radioscience Laboratory, Stanford University, Stanford, CA 94305. Other members of the selection committee include Professor P.M. Banks, Professor R.N. Bracewell, Professor L.R.O. Storey, and Professor L. Tyler.

Scripps Institution of Oceanography

Postdoctoral in Physical Oceanography

Scripps Institution of Oceanography invites applications for a Postdoctoral position in Physical Oceanography to participate in theoretical and observational studies of the general circulation of the North Pacific Ocean. Ph.D. in physical or mathematical sciences, with a strong graduate level background in Fluid Dynamics, is required. Salary is commensurate with experience, with a minimum of $22,600 per annum. Position start date from October 1, 1984.

Please send resume and three letters of reference to Professor Pearn P. Niiler, Scripps Institution of Oceanography, A-030, La Jolla, CA 92093 by September 1, 1984.

The University of California, San Diego is an Equal Opportunity/Affirmative Action Employer.

Seismologist/Department of Geology/University of Illinois at Urbana-Champaign. Applications are solicited for a tenure track position at the Assistant Professor level in the general area of seismic imagery. The position is expected to be filled by Fall, 1985. Salary is commensurate with experience; an earned Ph.D. is required. A creative individual is sought who will develop a research program that can complement our existing programs in geodynamics, earthquake seismology, geotectonics, and rock/mineral physics. Specialists from subfields including reflection/refraction seismology, exploration seismology, marine or continental seismic profiling, and seismic tomography are encouraged to apply. An excellent research environment and outstanding facilities are available both in the Department of Geology and the University. Opportunity exists to interact with the Illinois State Geological Survey on campus. The successful candidate is expected to participate in all aspects of teaching and advising at the graduate and undergraduate levels. For equal consideration, interested individuals should send curriculum vitae, list of publications, statements of research interests and names of three or more references by December 15, 1984 to:
Professor Albert T. Hsui
Department of Geology
University of Illinois at Urbana-Champaign
1301 W. Green Street
Urbana, Illinois 61801
Telephone: 217-333-7732 or 333-3542
University of Illinois is an equal opportunity/affirmative action employer.

Ecologist Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). The National Sea Grant College Program (NSGCP), Office of Oceanic and Atmospheric Research, NOAA, announces a vacancy for the position of Ecologist, GM-408-13/14, Rockville, Maryland. Vacancy closes September 1984. Incumbent will direct Office of Sea Grant program in environmental studies and serves as an advisor and consultant with NSGCP. Within the area of environmental studies, maintains cognizance of Sea Grant efforts nationwide. Directs and develops programs concerned with environmental studies focused on marine resource development and marine environmental quality problems. Participates in planning Sea Grant Budgets. Maintains responsibility through whole cycle of grant applications; reviews, evaluates and recommends undergraduate grants; conducts on-site review of institutional programs. Persons interested in applying MUST request a copy of the vacancy announcement by writing to NOAA, 6001 Executive Boulevard, Rockville, MD 20852, attn: R. Williams, RAS/DC21, or calling 301-443-8425. Applications should be submitted on Standard Form 171.
Department of Commerce is an equal opportunity employer.

University of Texas at Austin. The Department of Geological Sciences seeks to fill tenure track positions effective fall 1985 in one or more of the following disciplines: 1) micropaleontology-Tertiary biostratigraphy, 2) structure-tectonics, 3) hydrogeology, and 4) mineralogy-kinetics. Each person is expected to teach both undergraduate and graduate courses and to conduct a vigorous research program, including the supervision of graduate students, in the area of his or her specialty. The positions require the Ph.D. degree. Applicants should submit a detailed resume, names and addresses of five references, a statement of teaching and research interests, and a copy of their dissertation abstract by December 1, 1984 to: Dr. William L. Fisher, Department of Geological Sciences, the University of Texas at Austin, Austin, Texas 78713-7909.
The University is an equal opportunity/affirmative action employer.

Request for Preproposals. The U.S. Environmental Protection Agency's Corvallis Environmental Research Laboratory is seeking PREPROPOSALS for research on the effects of acidic deposition on the chemistry of surface waters. The purpose of the research will be to improve our understanding of the mechanisms of surface water acidification with the ultimate goal of predicting such effects of acidic deposition on regional and national scales. Specific areas of research to be addressed are: (1) retention of sulfate within soils; (2) flux of base cations from soils; (3) hydrologic response of watersheds; and (4) development/application of watershed-scale models for prediction of future effects. Written requests for information on preproposal submission are to be received not later than September 14, 1984, and are to be forwarded to: Dr. Raymond G. Wilhour, Chief, Air Pollution Effects Branch, U.S. Environmental Protection Agency, 200 S.W. 35th Street, Corvallis, Oregon 97333. Please specify research area of interest.

Processing Specialist. Processing Specialist needed to analyze and resolve geophysical-geological problems as assigned by clients. Make progress and interim evaluation reports. Identify pertinent facts concerning a data set. Present solution in writing and/or orally as required. Analyze data and design procedure for solution. Use seismic application software to process and display data. Specify and/or write additional application software and integrate software into existing system. Document and train others to use software. Requires a Master of Science degree in Geology/Geophysics and one year experience in job offered or one year directly related geophysical experience. Coursework must include strong background in physics and mathematics. Must also have courses in partial differentials, Fourier Analysis and linear algebra. Must have knowledge of Fortran computer language and VAX and Prime 550 computers. Must have experience or knowledge in 3D Seismic Data. 40 hour work week. $2,300.00 per month. Apply at Texas Employment Commission, Dallas, Texas, or send resume to the Texas Employment Commission, TEC Building, Austin, TX 78778. Job order #3609812.
Ad paid by an Equal Employment Opportunity Employer.

Hydrogeologist/Texas A&M University. The Department of Geology and Center for Engineering Geosciences have a tenure track opening, preferably assistant professor level, for which the first search will be for a creative individual working in applied geological hydrology.
The successful applicant will be expected to develop teaching and research recognition at a national level. The position is available beginning September 1, 1984 and will be held open until filled. Applicants should submit a vita including names of references to M.C. Gilbert, Department of Geology, Texas A&M University, College Station, TX 77843.
Texas A&M University is an affirmative action/equal opportunity employer.

Oceanographer at Stony Brook. We anticipate a tenure track position at Assistant Professor level for physical oceanographer, coastal geologist, or coastal engineer. Interest in coastal ocean dynamics, waves, or shore processes preferred. Position carries full support for the academic year and could be available as early as January 1985. Candidates should send a resume and the names of three individuals from whom letters of reference may be obtained to: Dr. Robert E. Wilson, Marine Sciences Research Center, SUNY Stony Brook, Stony Brook, NY 11794-5000. Closing date 15 October 1984.
SUNY Stony Brook is an affirmative action/equal opportunity educator and employer. AK#170

Faculty Positions in Geophysical Sciences/The University of Chicago. The Department of the Geophysical Sciences invites applications for positions at all levels across the entire range of earth and planetary sciences, including meteorology and oceanography. Particular attention will be given to applications in interdisciplinary areas with prospects of major advances in observation, theory and application. Please send resume and reprints to Joseph V. Smith, Chairman, Appointments Committee, 5734 South Ellis Avenue, Chicago, Illinois 60637, USA. Applications will be considered rapidly throughout the year.
The University of Chicago is an equal opportunity/affirmative action employer.

POSITIONS WANTED

Exploration Geologist. Specializing in resource exploration and development (mineral, petroleum, and groundwater-also mining and petroleum engineering). Johns Hopkins PhD with extensive practical experience in the Middle East and elsewhere. Multilingual (fluent in Persian and Turkish). Reply to Box 025, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C. 20009.

SERVICES, SUPPLIES, COURSES, AND ANNOUNCEMENTS

ADVANCES IN REMOTE SENSING RETRIEVAL METHODS

October-November 1984 Interactive Workshop on Advances in Remote Sensing Retrieval Methods, Williamsburg, VA, October 30-November 2. Sponsored by Office of Naval Research, NASA Headquarters, and Air Force Office of Scientific Research; organized by Institute for Atmospheric Optics and Remote Sensing. Extended date for abstracts, August 15, 1984.

The main objectives of the workshop are to bring together researchers in the various related fields of remote sensing to discuss the present state of knowledge of retrieval methods in seven broad areas, namely:

Area 1. Remote Sensing by Tomographic Techniques
Area 2. Remote Sensing by Geometric Methods
Area 3. Retrieval Methodologies
Area 4. Multidimensional Methods
Area 5. Artificial Intelligence Methods, Pattern Recognition, and Classification
Area 6. Intercomparisons of Inversion Methods
Area 7. Data Compaction and Management Techniques

Inquiries/Abstracts to: Dr. A. Deepak, IFAORS, P.O. Box P, Hampton, VA 23666, Telephone: 804/865-0811.

Call for Papers
Silicic Domes

Manuscripts are requested for possible inclusion in Geological Society of America Publication on the emplacement of silicic domes and lava flows.

Deadline: October 31, 1984.

For more information, contact:

Jonathan Fink
Geology Department
Arizona State University
Tempe, Arizona 85287
(602) 965-3195.

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Bacon-Bercey Award to Dignon

Nancy E. Dignon, a graduate student at Florida State University in Tallahassee, is the recipient of the 1984 June Bacon-Bercey Scholarship for Women in Atmospheric Sciences. The scholarship, administered by AGU, is provided through a gift from the noted meteorologist June Bacon-Bercey.

Dignon's interest in meteorology developed during her undergraduate studies at the State University of New York at Oneonta. While working there on her bachelor of science degree in meteorology, which she completed in May 1983, she developed a strong interest in severe storms and hurricanes. During the past year at Florida State, she has taken courses in tropical meteorology, mesoscale meteorology, numerical weather prediction, and atmospheric circulations. She hopes to work for a government research group following completion of a master's degree and possibly a Ph.D. She is currently working under the guidance of T. N. Krishnamurti on research involving detailed diagnoses of past hurricanes.

While not engaged in her research, Dignon, a native of Commack, N.Y., enjoys tennis and skiing.

Dignon is the seventh recipient of the Bacon-Bercey Scholarship. Offered to first-year graduate students, to undergraduates who have been accepted to graduate programs, and to students beginning a B.A. program after receiving an A.A., the $500 award is given to a woman who is starting out on a promising career in the atmospheric sciences. AGU's Education and Human Resources Committee, in consultation with the AGU Atmospheric Sciences Section, selects the winner.

AGU is again offering the scholarship for the 1985–1986 school year. For application forms and for details about eligibility requirements, write or call AGU Member Programs Division, 2000 Florida Ave., N.W., Washington, DC 20009 (telephone: 202-462-6903). The deadline for applications is May 1, 1985.—*BTR*

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NOMINATIONS FOR AGU FELLOWS AND AWARDS

September 15 is the deadline for nominations from the membership for AGU Fellows. Special nomination forms are available for your use in nominating a friend or colleague as a Fellow.

November 1 is the deadline for nominations for awards for 1985. Nominations are being accepted for the William Bowie, Waldo E. Smith, John Adam Fleming, Walter H. Bucher and Maurice Ewing Medals and the James B. Macelwane Awards. Letters of nomination outlining significant contributions and curriculum vitae may be sent directly to AGU for forwarding to the appropriate selection committee.

For Fellows nomination forms, information on criteria for the awards, or a list of past recipients call or write:

Member Programs
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009
(Telephone: 462-6903
or toll free: 800/424-2488
outside the Washington D.C. area)

The June Bacon-Bercey Scholarship in Atmospheric Sciences for Women 1985—1986

Expressly for women intending to make a career in the atmospheric sciences. This monetary assistance, provided through a gift from June Bacon-Bercey, a noted meteorologist, will be given to a woman who shows academic achievement and promise. To qualify, candidates must be one of the following:

- a first-year graduate student in an advanced degree program in atmospheric sciences;
- an undergraduate in a bachelor's degree program in atmospheric sciences who has been accepted for graduate study;
- a student at a 2-year institution offering at least six semester hours of atmospheric sciences, who has been accepted for a bachelor's degree program, and who has completed all of the courses in atmospheric science offered at the 2-year institution.

Awardee selection will be made by the AGU Education and Human Resources Committee in consultation with the AGU Atmospheric Sciences Section.

For application forms contact:
American Geophysical Union
Member Programs Division
2000 Florida Avenue, N.W.
Washington, D.C. 20009
(202) 462-6903
Application Deadline May 1, 1985

Meetings

Announcements

Space Simulation

October 8–11, 1984 18th Space Simulation Conference, Orlando, Fla. Organizers: Institute of Environmental Sciences, NASA, American Institute of Aeronautics and Astronautics, and American Society for Testing and Materials. (18th Space Simulation Conference Registration, Institute of Environmental Sciences, 940 East Northwest Highway, Mount Prospect, IL 60056; tel.: 312-255-1561.)

The conference is subtitled "The Payload—Testing for Success." Among the topics to be discussed are space simulation testing of the earth radiation budget satellite; simulation of upper atmosphere oxygen; the repair of the Solar Maximum Mission satellite; and measurements and techniques.

Russell T. Hollingsworth of the NASA Goddard Space Flight Center is the general chairman. Robert P. Parrish, Jr., of the Martin Marietta Corp., is the chairman of the technical program.

Groundwater Meeting

October 29–31, 1984 Symposium on Groundwater: The Unseen Crisis, Austin, Tex. Sponsors: Texas A & M University, University of Texas at Austin. (Ernest T. Smerdon, Center for Research in Water Resources, The University of Texas at Austin, Building 119, 10100 Burnet Road, Austin, TX 78758–4497; tel: 512-835-3112.)

The symposium will feature five half-day sessions addressing the following general topics: overview and outlook for groundwater (including a retrospective analysis, groundwater status, and legislative initiatives); regional aquifers and their unique problems (including the Edwards, Ogallala, and coastal aquifers as well as interstate and international aquifers); policies, laws, and institutions; groundwater contamination: monitoring, analysis, and control (including quality issues associated with mining, toxic wastes, and groundwater clean up); and groundwater management and conservation (including large-scale aquifer management, conjunctive use, optimization models, and secondary recovery).

Antenna Meeting

November 13–15, 1984 1984 International Symposium on Antennas, (Journees Internationales de Nice sur les Antennes—JINA), Nice, France. Organizers: France's Centre National d'Études des Télécommunications (CNET) and Société des Électriciens, des Électroniciens et des Radioélectriciens. (Secrétariat JINA '84, CNET-PAB, Centre de la Turbie, 06320 Cap d'Ail, France.)

Among the topics to be covered are telecommunications antennas; scattering, imaging, and near field; microstrip and array antennas; large antenna systems for satellite communications applications; and numerical and analytic techniques applied to antenna design.

Water and Air

Jan. 7–11, 1985 International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, Los Angeles, Calif. Sponsor: AMS. (G. Stanley Doore, Office of the Federal Coordinator, 11426 Rockville Pike, Suite 300, Rockville, MD 20852; tel.: 301-443-8704.)

The deadline for abstracts is September 1, 1984.

Papers are solicited on the following topics, among others: photogrammetry, cartographics, and mapping technologies; monitoring and quality control of data, information, and systems; interactive systems, for centers, forecast, and warning offices, television stations, and research; teleconferencing and local area, national, and international data networks; distribution and dissemination systems; systems, technologies, and applications for developing countries; display and computer systems, architecture, and technology; personal computers and terminal-based technology; data base architecture, interaction, applications, and availability; logistics and physical security; and management, training, and coordination.

Tours to nearby facilities are being planned.

Rock Mechanics

June 26–28, 1985 U.S. Symposium on Rock Mechanics, Rapid City, S. Dak. Sponsor: South Dakota School of Mines and Technology. (Eileen Ashworth, Chairman, 26th U.S. Symposium on Rock Mechanics, Dept. of Mining Engineering, South Dakota School of Mines and Technology, Rapid City, SD 57701–3995; tel.: 605-394-2344.)

Deadline for abstracts (500–800 words plus one or two figures) is October 15, 1984.

Among the topics identified for discussion at the meeting are rock mass characterization (including laboratory testing, in situ testing, structural properties, and geological factors); heat and fluid flow (including theory and applications, enhanced oil recovery, in situ processing, phase change problems, and hydrofracturing); in situ stress (including methods for determination and application of results in design); design of structures in rock masses (including permanent structures, semipermanent structures for mining, and rock fragmentation); and modeling of rock mass behavior (including numerical, statistical, and physical modeling).

Call for Papers

Abstracts must be received at AGU by 5 P.M., **September 12, 1984.** Late abstracts (1) may be summarily rejected by program chairman, (2) may not be published in advance of the meeting, and (3), if accepted, will be charged a $25 late fee, in addition to the regular publication charge.

The 1984 Fall Meeting of the American Geophysical Union and the American Society of Limnology and Oceanography's (ASLO) Winter Meeting will be held in San Francisco, December 3–7, at the Civic Auditorium. Blocks of sleeping rooms are being held at the Cathedral Hill, Holiday Inn-Golden Gateway, Holiday Inn-Civic Center, the San Franciscan Hotels and at several Best Western motels. Corresponding authors will be sent housing and registration forms. In addition, these forms will be published in *Eos*.

General Regulations

- Abstracts may be rejected without consideration of content if they are not received by the deadline date or are not in the proper format. Abstracts also may be rejected if they contain material outside the scope of AGU activities, if the material has been published previously, or presented elsewhere. **Only one contributed paper by the same first author will be considered for presentation;** additional papers (unless invited) will be rejected automatically.
- Only AGU and ASLO members may submit an abstract. The abstract of a nonmember must be accompanied by a membership application form (with payment) or it must be sponsored by an AGU member.
- There is a publication charge of $40 ($30 if prepaid) for each abstract. The publication charge is $20 when the first author is a student. Both invited and contributed papers are subject to the publication charge. Prepayment of the publication charge can save money. Send a check for $30 ($15 for students) with your abstract. The abstract must be received at AGU by September 12 to avoid an additional $25 late charge. Abstracts not prepaid will be invoiced prior to the meeting. Payments will be accepted at the meeting.
- AGU will acknowledge receipt of all abstracts. Notification of acceptance and scheduling information will be mailed to corresponding authors in late October.

Abstracts

The abstract page is divided into two parts: the abstract itself and the submittal information. Follow the instructions for both carefully. Copy must be of letter quality type. Do not exceed the maximum dimensions specified for the type of presentation you are requesting (11.8 cm x 18 cm for oral or title; 11.8 cm x 28 cm for a poster). Abstracts which are submitted for poster presentation must be typed on legal size paper, not on two sheets of paper. **Abstracts that exceed the noted size limitations will be trimmed to conform.**

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Submittal Information (see sample abstract)

Numbers refer to the items in the submittal block on the sample abstract.

1. Title of meeting.
2. Identification (only members may submit an abstract; this includes invited authors): Type the identification number of one member author (ID number is the line consisting of four letters followed by the six digits; see member's mailing label on *Eos* or journals), or if no author is an AGU member, type the ID number of the member sponsor (sponsor's name must also appear on the abstract at the end of the author portion). If no ID number is given, a membership application and dues payment must accompany the abstract. For an application call AGU toll free at 800-424-2488; local 462-6903; or Telex 710-822-9300. ASLO members type ASLO on line 2.
3. Corresponding address: Give complete address and phone number of author to whom all correspondence (acknowledgment and acceptance letters) should be sent. Abbreviate as much as possible.
4. Section to which abstract is submitted (use the following letter abbreviations): A (Atmospheric Sciences); G (Geodesy); GP (Geomagnetism and Paleomagnetism); H (Hydrology); O (Ocean Sciences); P (Planetology); S (Seismology); SA (Aeronomy); SM (Magnetospheric Physics); SC (Cosmic Rays); SS (Solar and Interplanetary Physics); T (Tectonophysics); V (Volcanology, Geochemistry, and Petrology); U (Union); (Mineral Physics) submit to above section as appropriate and note mineral physics as special session. Use ASLO for American Society of Limnology and Oceanography.
5. Type title of special session (if any) to which submittal is made.
6. Indicate your preference for a particular kind of presentation by one of the following letters: O, oral; P, poster; T, title. Abstract dimensions for an oral presentation or title only are 11.8 cm x 18 cm. Abstract dimensions for a poster paper preference are 11.8 cm x 28 cm. Abstracts which exceed the maximum dimensions specified for the type of presentation requested will be trimmed to conform. The chairman may assign you to one of these types of presentation in order to fit the program plan. Program Chairmen have absolute authority to schedule papers for the type of presentation which fits their program. If you wish to withdraw your paper rather than present it in a form other than specified, so indicate.
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Poster Sessions

Experience from AGU meetings and from other scientific societies has shown that a poster presentation, while more demanding of the author, can provide a superb opportunity for comprehensive discussions of research results. Some sections are organizing poster sessions on specific topics, and contributed papers on these subjects will automatically be scheduled as posters. In other sections it may be necessary to assign papers to poster sessions even though their authors requested oral presentation.

Presenters of poster papers are reminded that a poster exhibit requires careful preparation. Figures and text should be scrutinized in detail, and authors must be prepared to discuss the contents of their papers in depth. Under these conditions, well-prepared figures and concise, logical text are essential.

TRAVEL GRANTS TO IASPEI REGIONAL ASSEMBLY HYDERABAD, INDIA

Deadline for Applications August 31, 1984

AGU has applied for grant funds to assist the travel of individual U.S. scientists to the IASPEI Regional Assembly to be held in Hyderabad, India, October 31—November 7, 1984. In anticipation of receipt of this funding, application forms for individual grants are available from:

American Geophysical Union
2000 Florida Avenue, N.W.
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Program Committee

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American Society of Limnology and Oceanography (ASLO) Patricia Kremer, University of Southern California, Los Angeles
Atmospheric Sciences (A) Rex J. Fleming, NOAA, Rockville, Maryland
Geodesy (G) Ross Stein, USGS, Menlo Park, California
Geomagnetism and Paleomagnetism (GP) Michael McWilliams, Stanford University
Hydrology (H) Dennis Lettenmaier, University of Washington, Seattle
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SPR: Cosmic Rays and Solar and Interplanetary Physics (SC/SS) Leonard Burlaga, NASA/GSFC, Greenbelt, Maryland (SC); Bruce T. Tsurutani, Jet Propulsion Laboratory (SS)
SPR: Magnetospheric Physics (SM) George K. Parks, University of Washington, Seattle
Tectonophysics (T) Barry Parsons, Massachusetts Institute of Technology
Volcanology, Geochemistry, and Petrology (V) Bruce G. Marsh, Johns Hopkins University, Baltimore, Maryland

Special Sessions

(an asterisk indicates new special session)

Union (U)

Nuclear Waste Disposal
Sea Level Changes
Properties of Geological Materials

American Society of Limnology and Oceanography (ASLO)

Biochemical Approaches to Plankton Growth
Dynamics of Bio-Optical Interactions
Influences of Diel Photocycles on Physiology and Ecology of Plankton
Effects of El Nino (including Atmospheric, Resource, Evolution)
Larval Ecology
Sulfur Cycling in Organic Rich Environments
Southern Oceans
Aquatic Nitrogen Cycles: Problems and Perspectives
Small-Scale Physics and Aquatic Ecology
*Warm—Core Rings

Atmospheric Sciences (A)

Mesoscale Convective Systems and the Storm Program
Chemistry of the Global Atmosphere
Acid Deposition Modeling
Interannual Climate Variability: ENSO and the TOGA Program
Water on Mars (jointly sponsored with P)

Geodesy (G)

Intercomparison of Geodetic Measurements
Geodetic Networks and the Observation of Premonitory Deformation
Measurement of Seafloor Deformation
Geodetic Instrumentation Development

Geomagnetism and Paleomagnetism (GP)

*A Critical Look at Reference APW Paths for North America
*Workshop on Paleomagnetic Data Analysis
*Asian Paleomagnetism and Paleogeography

Hydrology (H)

History of Hydrology: Earth Sciences Aspects
Statistical and Hydrological Criteria in the Safety of Dams

Meetings (cont. on p. 448)

Meetings (cont. from p. 447)

Paleoflood Hydrology
Fluvial Transport of Sediment-Associated Contaminants
Advances in Snowmelt Run Off Modeling
Evapotranspiration Modeling: It's Verification and Use
New and Emerging Issues in Water Resources Law, Economics, and Public Policy
Quantitative Precipitation Forecasting Models and Procedures Potentially Useful to Hydrologic Forecasting
Microbial Activity in Groundwater
Uncertainty in Water Quality Modeling and Management
Isotope Technique in Ground Water Tracing and Age Dating

Ocean Sciences (O)

Marginal Seas and Straits
Tropical Pacific Ocean Circulation
Coastal Ocean Dynamics
Mid-Latitude Large-Scale Circulation
*Sequal and Focal Tropical Atlantic Studies
Large-Scale Air-Sea Interactions Remote Sensing for Climate Research
Short-Term Climate Variability and Tropical-Extratropical
Interactions in the Pacific Sector
*Intraseasonal Climate Variability: Tropical—Extratropical
Air-Sea Interactions and the CO2—Climate Problem
Marginal Ice Zone Processes
Redox Processes in the Marine Environment
Early Diagenesis in Marine Sediments
Exchange Across Sediment-Water Interface
Chemical Tracers in the Oceans
General Marine Chemistry
*Paleochemistry and Paleoclimate of the Oceans

Planetology (P)

Water and Mars (jointly sponsored with A)
Io

Seismology (S)

California Earthquake and Tectonics
Deep Earth Structure
Nature and Evolution of the Continental Lithosphere
Nature and Evolution of the Oceanic Lithosphere

The Seismology Section is considering an experiment which will illustrate the complementary merits of poster sessions in which complex data can be presented and studied at length, and oral sessions which can quickly capture the attention of large audiences on specific points. Authors presenting a paper in the sessions on Nature and Evolution of Continental Lithosphere or Nature and Evolution of the Oceanic Lithosphere will be allowed to present an oral paper in the morning and a supplementary poster paper in the afternoon with the same first author. This format is designed for papers requiring large displays (e.g. maps, seismic sections, images), and should provide an attraction as an alternative to a series of oral papers with a permutated set of authors.

SPR: Aeronomy (SA)

Lower Thermosphere Oxygen Airglow
Modeling of the Aurora and Airglow
Middle Atmosphere Chemistry and Dynamics
Recent Advances in Airglow Auroral Observations
Thermosphere Dynamics
Ionosphere Electric Fields

SPR: Cosmic Rays and Solar and Interplanetary Physics (SC/SS)

Cosmic Ray Modulation
SMM (Solar Maximum Mission) Repair and Results (oral and poster sessions)

SPR: Magnetospheric Physics (SM)

High Latitude Lobe Observations
Polar Cap Observations
Boundary and Boundary Layers
Magnetic Neutral Lines
Particle Injection and Precipitation
Wave-Particle Interactions
Auroral Double Layers

Tectonophysics (T)

Memorial Session for John Jamieson: High Pressure Geophysics
Seamount (cosponsored by V)
Frontiers of Tectonophysics
*Targets for Continental Scientific Drilling

Volcanology, Geochemistry, and Petrology (V)

Diagensis and Fluid Flow in Porous Reservoirs
Archaen Tectonics and Geochemistry (cosponored by T)

Mineral Physics

If one of the following fields is covered in the broadest sense, regardless of the section to which your paper is submitted, please add on your abstract, under number 5 of the submittal information, the phrase "For Mineral Physics Session," and one of the following fields: (1) physical measurements on minerals, (2) calorimetry, (3) high-pressure mineralogy, (4) defect structure studies, (5) mineral and solids equations of state, (6) quantum mechanics of solids, (7) spectral mineralogy, or (8) electrical measurements on minerals.

Session Highlights

American Society of Limnology and Oceanography (ASLO)

Presentations are to evaluate biochemical indices of growth or physiological activity (i.e., rates of cellular processes by isotope incorporation, enzyme activities, etc.) in freshwater and marine bacteria, autotrophs, zooplankton, and larval nekton from laboratory or natural populations. "New" approaches from the biochemical literature should examine the technique with regard to its application in natural populations. Session cochairman are Ian Morris, Horn Point Environment, and Gary Hitchcock, Nova University.

Influences of Diel Photocycles on Physiology and Ecology of Plankton

This session will include the regulatory role of the photocycle on the organismal, population, and community level. Discussions will include freshwater and marine systems, and both autotrophic and heterotrophic plankton. This session will be chaired by S. W. Chisholm, Massachusetts Institute of Technology.

Aquatic Nitrogen Cycles

During the past 20 years, there has been an explosion of interest and information dealing with aquatic nitrogen cycling, but fundamental questions unanswered. In this session we shall attempt to summarize present knowledge, identify major problem areas in our understanding of aquatic nitrogen transformations and budgets, and inquire into promising directions for future research. This session will be chaired by Lou Codispoti, Bigelow Laboratory for Ocean Sciences.

Warm-Core Rings: Synthesis

The Warm Core Rings Program has conducted a multidisciplinary time-series study of one ring (82-B), and made single time point observations in four other rings for comparative purposes. This special session provides the opportunity to synthesize current information and discuss new insights into the structure and dynamics of these mesoscale eddies and their impact on the surrounding hydrographic regimes. The session chairman is Peter Wiebe, Woods Hole Oceanographic Institution.

Small-Scale Physics and Aquatic Ecology

The interaction of biotic and abiotic particles is governed by hydrodynamic, diffusive, and chemical factors traditionally considered in filtration and coagulation theories but not in ecological contexts. This symposium will explore recent work applying similar theories to ecological situations. The session chairman is George Jackson, Scripps Institution of Oceanography.

The Columbia River Estuary: Biological and Physical Processes

Results will be presented from a 3-year multidisciplinary program which investigated physical, biological, and sedimentation processes in the Columbia River Estuary. The emphasis of the session will be on integrating the physical and biological studies to understand the ecological dynamics of the estuary. Session cochairmen are Peter Hamilton, Science Applications, Inc., and Larry Small, Oregon State University.

Atmospheric Sciences (A)

A call for papers in the area of Atmospheric Electricity and Lightning Research has been issued by the AGU Committee on Atmospheric and Space Electricity (CASE). CASE will hold its annual meeting in the evening following the electricity session(s); the CASE meeting is open to non-voting participation by interested AGU and AMS members. The session chairman is Arthur J. Few, Jr., Rice University.

Geodesy (G)

Geodetic Instrumentation Development

This session will focus upon the most recent geodetic hardware development and the future course of instrument development. Emphasis will be placed on accuracy, cost, and predicted characteristics of nearly operational equipment. We encourage the reporting of results that are demonstrative of instrument accuracies. The session chairman is Admiral John D. Bossler, NOAA, Rockville, Maryland.

Sample Abstract (See explanation)

11.8 cm — **18 cm**

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Extended abstract dimension available at no increased cost to those who request poster presentation.

(For details see submittal information #6)

Abstract Deadline: September 12, 1984

Mail original and two copies to:

Fall Meeting
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Intercomparison of Geodetic Measurements

The crucial and continuing need to test different geodetic measurement systems against each other will be addressed in this session. The relative performance of short-baseline tilt, strain, and dilitation meters at Pinon Flat Observatory, and the temporal relation between gravity, elevation, and strain in Southern California, will be aired. In addition, high-accuracy relative position measurements can now be performed using ground-based receivers and the NAVSTAR satellite Global Positioning System (GPS). The USGS/NGS/DMA intercomparison of single and dual-frequency receiver and software systems and several radiometers in January 1984 will be presented. The session chairman will be Randolph H. Ware at CIRES.

Geodetic Networks and the Observation of Premonitory Deformation

The detection of premonitory deformation is vital to medium- and short-term earthquake prediction. This session will focus on the design and results of networks emplaced to provide more definitive evidence on this question. Emphasis will be on brief critical reviews of the record for past earthquakes, the theoretical and laboratory work that attempts to identify the magnitude and timing of deformation, and the design and implementation of networks that can reliably detect such deformation. Contributions are particularly encouraged which address the critical question of the spatial character and time constant of premonitory fault slip. Session cochairmen are Allan Lindh and William Prescott at U.S.G.S., Menlo Park, California.

Measurement of Seafloor Deformation

The largest plate boundary and intraplate deformation events take place undersea, during great underthurst earthquakes and volcanic seamount eruptions, beyond the reach of conventional geodesy. This session will include treatment of both newly emerging possibilities (GPS interferometry, precision acoustic transponders, and repeat SEASAT seasurface altimetry) and existing techniques (pressure transducers, tiltmeters, and seabottom imaging) in the context of documenting various styles of seafloor deformation, which may occur in immediate offshore areas and in the deep sea. The session chairman is Fred N. Spiess of Scripps Institution of Oceanography.

Geomagnetism and Paleomagnetism (GP)

A Critical Look at Reference APW Paths for North America

Anomalous paleomagnetic results from North America orogens are now accumulating at a much faster pace than are new results from the stable interior. Many of the older data from which the reference APW paths are constructed warrant closer scrutiny, and new reference data are needed to augment specific time intervals. As expected and measured terrane displacements become increasingly smaller, and as the need to delineate interterrane movements becomes more important, better reference paths are a necessity. This session will focus upon (1) identification of gaps in APWP reliability for the Phanerozoic, (2) current efforts by research groups to fill these gaps, and (3) the focus of future reference APWP studies. A significant amount of discussion time will be scheduled for informal comment and presentation.

Dynamics of Bio-Optical Interactions

Upper ocean optical variability is influenced by biological and physical forcing. This session will be devoted to observational and modeling studies of these interactions. The session chiarman in Tom Dickey, University of Southern California.

Asian Paleomagnetism and Paleogeography

Workers at many paleomagnetic laboratories in Asia, North America, Europe and Australia are conducting paleomagnetic research aimed at deciphering the displacement history of the tectonic blocks which comprise Asia. New data and interpretations are available from the major cratons and from marginal terranes. This session will serve as a forum for presentation of new data by the various research group, as a vehicle for discussion and debate of tectonic interpretations.

SPR: Solar and Interplanetary Physics (SS)

Solar Maximum Mission Special Sessions

Session 1: This will be comprised of an overview of the SMM repair and science, together with invited papers from each experiment team. The session will draw together mission results and focus on solar-terrestrial relations. New results since the repair will be introduced. Session 2: A special poster session is being designed as a forum for the visual displays of SMM and related results that are now becoming available. It will be scheduled in coordination with session 1. Papers deserving more extensive discussion and containing especially exciting or complex displays are particularly appropriate.

Workshop on Paleomagnetic Data Analysis

Each paleomagnetic research group has different ideas about the analysis and presentation of paleomagnetic data, including the choice of demagnetization strategies, identification and isolation of superimposed magnetizations, rejection criteria, estimating paleomagnetic directions and associated errors, and APW path construction. Following the successful "workshop" format of last year's session "Problem Solving with Rock Magnetic Techniques," this session will focus on the presentation of documented examples illustrating the merits of analytical techniques used by different groups. Topics for consideration run from analysis of a single demagnetization experiment to the creation of APW paths. Ample time for informal discussion and presentation will be scheduled.

GAP

Separates

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Particles and Fields—Magnetosphere

5705 Bow shock waves
ION AND ELECTRON HEATING AT COLLISIONLESS SHOCKS NEAR THE CRITICAL MACH NUMBER
M. F. Thomsen (MS D438, Los Alamos National Laboratory, Los Alamos, NM 87545), J. T. Gosling, S. J. Bame, and M. M. Mellott

The evolution of the ion and electron distribution functions across a set of 10 low Mach number, nominally subcritical, quasi-perpendicular shocks is examined in high time resolution (full distribution every three seconds) using data from the ISEE-1 and -2 spacecraft. Both ions and electrons sometimes show slight preheating upstream of the shock, but otherwise the ion and electron temperatures rise together in the magnetic ramp and show no further increase downstream. Contrary to the usual assumption based on early laboratory and theoretical work that at subcritical shocks the bulk of the energy dissipation occurs as resistive heating of the electrons, it is found that the ion temperature increase exceeds that of the electrons. This difference is attributed to the distinction between dispersive shocks, such as those studied here, and resistive shocks, such as those observed in most laboratory studies. The increase in ion temperature is predominantly in the perpendicular direction and is due to heating of the entire distribution rather than to the formation of a high-energy tail. The perpendicular temperature increase is typically a factor of 10-20, much greater than the usual assumption of adiabatic heating. The downstream to upstream ratio of perpendicular electron temperature is equal to the magnetic field ratio, ~2 to 2.5. The electrons also show significant heating in the parallel direction, with the downstream $T_{\parallel}/T_{\perp}$ ~1 to 1.2. The downstream electron distribution exhibits the characteristic flat top seen downstream of supercritical shocks, and there is evidence for the field-aligned electron beam identified previously within those shocks. As previously reported, the downstream ion and electron total temperatures are nearly equal. These observations are interpreted as evidence for the simultaneous operation of several plasma instabilities, including the modified two-stream instability, driven by the cross-field current within the shock, and the ion acoustic instability, driven by the field-aligned electron beam. (Heating, collisionless shocks, subcritical).

J. Geophys. Res., A, 4A1012

5705 Bow Shock Waves
WHISTLER DAMPING AT OBLIQUE PROPAGATION: LAMINAR SHOCK PRECURSORS
S. P. Gary (ESS-8, Mail Stop D438, Los Alamos National Laboratory, Los Alamos, NM 87545) and M. M. Mellott

This paper addresses the collisionless damping of whistlers observed as precursors standing upstream of oblique, low Mach number terrestrial bow shocks. The linear theory of electromagnetic waves in a homogeneous Vlasov plasma with Maxwellian distribution functions and a magnetic field is considered. Numerical solutions of the full dispersion equation are presented for whistlers propagating at an arbitrary angle with respect to the magnetic field. It is demonstrated that electron Landau damping attenuates oblique whistlers and that the parameter which determines this damping is β_e. In a well defined range of parameters, this theory provides damping lengths which are the same order of magnitude as those observed. Thus electron Landau damping is a plausible process in the dissipation of upstream whistlers. Nonlinear plasma processes which may contribute to precursor damping are also discussed, and criteria for distinguishing among these are described.
J. Geophys. Res., A, Paper 4A8046

5705 Bow shock waves
NUMERICAL STUDY OF THE UPSTREAM WAVE EXCITATION MECHANISM: 1. NONLINEAR PHASE BUNCHING OF BEAM IONS,
M. Hoshino (Institute of Space and Aeronautical Sience, Komaba, Meguro, Tokyo 153 Japan), and T. Terasawa

By means of the particles simulation, the excitation mechanism of low frequency (0.01-0.05Hz) upstream hydromagnetic waves are studied. Initially, we observed excitation of the right hand polarized waves propagating parallel to the field-aligned ion beam, which is given as the free energy source. In nonlinear stage, the phase space bunching of beam ions by the excited waves are observed. We propose here that the phase-bunching process by the excited waves is the origin of the "gyrophase bunched" ions observed in the upstream region: The "reflected" ions from the bow shock excite hydromagnetic waves, which then trap their parent ions. (Upstream, phase space bunching, gyrophase bunched ions).

J. Geophys. Res. A, Paper 4A8106

5705 Bow shock waves
GYRATING IONS AND LARGE-AMPLITUDE, MONOCHROMATIC MHD WAVES UPSTREAM OF THE EARTH'S BOW SHOCK
M.F. Thomsen (Los Alamos National Laboratory, Los Alamos, NM 87545), J.T. Gosling, S.J. Bame, and C.T. Russell

Episodes of nearly monochromatic, low-frequency (f ~ 0.03 Hz), hydromagnetic waves are occasionally observed upstream of the Earth's bow shock. These waves have previously been associated with suprathermal ions of the "intermediate" type of distribution and have been attributed to the early stage of disruption of a field-aligned ion beam through the electromagnetic ion beam instability. However, high time-resolution (3 sec) measurements of 2-dimensional ion distributions during two nearly monochromatic wave events reveal that the ion distributions associated with these waves are in fact "gyrating ions". Such distributions consist of suprathermal ions with parallel and perpendicular velocities confined to a fairly narrow range of gyrophase angle ("gyrophase-bunched"). In one of the two cases, the observed frequency of the waves agrees quite well with the Doppler-shifted resonance frequency of waves in right-hand resonance with the observed gyrating ions. In the second case, the observed frequency is lower than the predicted frequency by a factor of 1.5-2. (Gyrating ions, bow shock, upstream waves).

J. Geophys. Res., A, 4A8033

5720 Interactions between solar wind and magnetosphere
THE RELATION OF THE CUSP PRECIPITATING ELECTRON FLUX TO THE SOLAR WIND AND INTERPLANETARY MAGNETIC FIELD
N. Candidi, C. -I. Meng (The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland 20707)

The temporal variation of the precipitating electron flux in the energy range 47 eV to 1 keV detected in the low altitude cusp is studied as a function of the solar wind parameters and the interplanetary magnetic field (IMF) B_z component. It is found that the cusp electron flux intensity in the polar cusp region depends nonlinearly on the solar wind plasma density and also that it is higher in the negative IMF B_z period than in the positive IMF B_z period. Both these facts are consistent with the predictions of the existing models of magnetic field line merging at the magnetopause; however, the possibility that nonlinear diffusion processes predominate cannot be eliminated.

J. Geophsy. Res., A, Paper 4A0914

5736 Magnetotail
DOWNSTREAM PROPERTIES OF MAGNETIC FLUX TRANSFER EVENTS
D. G. Sibeck and G. L. Siscoe (Department of Atmospheric Sciences, University of California, Los Angeles, CA 90024)

We consider the downstream evolution of the tubes of field lines known as flux transfer events (FTE's) formed by the localized, dayside, sporadic merging of magnetosheath and magnetosphere magnetic field lines. FTE's have magnetic field and plasma properties distinct from those of the nearby unmerged magnetosheath and magnetosphere field lines. Tailward advection stretches these earth-rooted flux tubes and orients them parallel to the field in the magnetotail lobes.

Following dayside merging, magnetosheath plasma flows into the magnetosphere part of the FTE. This flow is modelled by a self-similar expansion of a plasma into a vacuum. The magnetosheath part of the FTE empties and the magnetosphere part fills with time. After the FTE has moved 200 R_E down the tail, the draped portion of the FTE reaches about 25 R_E radially outward from the tail boundary.

We suggest that most multiple crossings of the tail boundary observed by spacecraft are encounters with tailward moving FTE's. This interpretation explains fully the way boundary normals behave during multiple crossings. The previously favored interpretation, [illegible] explains the known behavior. The model explains how the sign of the IMF causes the observed dawn-dusk asymmetries in the thickness of the magnetotail boundary layer and in the pattern of 'lobe filling'. It also predicts that multiple boundary crossings should be correlated with negative IMF B_z.

J. Geophys. Res., A, Paper 4A8063

5736 Magnetic Tail
SURVEY OF ENERGETIC (E >35 KEV) ION ANISOTROPIES IN THE DEEP GEOMAGNETIC TAIL.
P.W. Daly (Space Science Dept., ESTEC, 2200 AG Noordwijk, Netherlands), T.R. Sanderson and K.-P. Wenzel.

An analysis of the direction and magnitude of the anisotropy of energetic ions (E > 35 keV) in the plasma sheet of the deep geomagnetic tail has been undertaken using data from the energetic particle anisotropy spectrometer on board ISEE-3 during its geotail mission. An ensemble of samples, consisting of 10-min averages of the data, has been chosen using selection criteria of magnetic field direction and particle intensity, such that the samples are predominantly in the plasma sheet or energetic ion boundary layer. No distinction between quiet and disturbed times is made in this study. Tailward and earthward flows are seen with nearly equal probability out to a distance of 100 R_E from the earth, beyond which tailward flow dominates. Beyond 150 R_E, tailward flow occurs in 95% of the samples. The average derived ion flow velocity in the tailward direction increases steadily with distance to 650 km s^{-1} at 230 R_E. The most common direction of ion anisotropy is 10° duskward of the GSM -X axis. The data are better ordered about this direction than about the direction of the magnetic field vector. This is explained by the presence of a transverse component of ion anisotropy in the duskward direction, the average value of which is independent of the strength of the tailward/earthward flow. It is argued that this transverse anisotropy is caused by a density gradient in the plasma sheet of scale length 2-3 R_E. (Energetic Particles, Geomagnetic tail, anisotropies, density gradients).

J. Geophys. Res., A, Paper 4A8165

5755 Plasma Instabilities
DRIFT-WAVE INSTABILITIES IN A HIGH β MULTISPECIES PLASMA
V. L. Patel (Department of Physics, University of Denver, Denver, CO 80208), P. H. Ng, G. R. Ludlow

The dispersion relation for drift-Alfvén waves in two-component (cold and hot), high β inhomogeneous multispecies plasma containing protons, oxygen and sulphur ions is solved numerically. The magnetic field is assumed to have a gradient in simple slab geometry configuration. The plasma ion composition consists of H, O, S, SO_2 and Na ions. The effect of heavy ions and multiple charge states (Z > 1) on the growth rates has been numerically estimated for assumed ion compositions. The numerical calculations of growth rates also have been performed using ion composition and plasma parameters based on Voyager spacecrafts in the magnetospheres of Jupiter and Saturn.
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5755 Plasma Instabilities
PLASMA HEATING AT COLLISIONLESS SHOCKS DUE TO THE KINETIC CROSS-FIELD STREAMING INSTABILITY
D. Winske (Los Alamos National Laboratory, Los Alamos, NM 87545), Motohiko Tanaka, C. S. Wu, and K. B. Quest

Heating at collisionless shocks due to the kinetic cross-field streaming instability, which is the finite beta (ratio of plasma to magnetic pressure) extension of the modified two stream instability, is studied. Heating rates are derived from quasilinear theory and compared with results from particle simulations to show that electron heating relative to ion heating and heating parallel to the magnetic field relative to perpendicular heating for both the electrons and ions increase with beta. The simulations suggest that electron dynamics determine the saturation level of the instability, which is manifested by the formation of a flattop electron distribution parallel to the magnetic field. As a result, both the saturation levels of the fluctuations and the heating rates decrease sharply with beta. Applications of these results to plasma heating in simulations of shocks and the earth's bow shock are described. (Plasma instabilities, bow shock).

J. Geophys. Res., A, 4A8112

5760 Plasma motion, convection, or circulation
DRIVEN MAGNETIC RECONNECTION IN THREE DIMENSIONS: ENERGY CONVERSION AND FIELD ALIGNED CURRENT GENERATION
Tetsuya Sato (Institute for Fusion Theory, Hiroshima University, Hiroshima 730, Japan), Raymond J. Walker and Maha Ashour-Abdalla (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California 90024)

We have analyzed the energy conversion processes occurring in three dimensional driven reconnection. In particular, we studied the energy conversion processes during localized reconnection in a tail like magnetic configuration. We find that 3D driven reconnection is a powerful energy converter which transforms magnetic energy into plasma bulk flow and thermal energy. Three dimensional driven reconnection is an even more powerful energy converter than 2D reconnection because in the 3D case plasmas were drawn into the reconnection region from the sides as well as from the top and bottom. Field aligned currents are generated by 3D driven reconnection. We have identified the physical mechanism responsible for these currents which flow from the tail toward the ionosphere on the dawn side of the reconnection region and from the ionosphere towards the tail on the dusk side. The field aligned currents form as the neutral sheet current is diverted through the slow shocks which form on the outer edge of the reconnected field lines (outer edge of the plasma sheet). (Reconnection, field aligned currents, substorms).

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5760 Plasma convection
ACCELERATION OF LITHIUM TEST IONS IN THE QUIET TIME GEOMAGNETIC TAIL
Sandra C. Chapman and S. W. H. Cowley (Blackett Laboratory, Imperial College, London SW7 2BZ, UK)

One of the active experiments to be performed as part of the AMPTE mission involves the release of lithium ions in the geomagnetic tail and their subsequent detection after Earthward convection into the nightside outer ring current region. We have used the guiding center approximation to integrate ion trajectories in a simple two-dimensional model of the quiet time nightside magnetosphere in order to estimate expected ion properties at the latter location. We find that the energy of the particles on arrival in the ring current region depends principally on the equatorial electric drift speed at the distance of the release, but is not sensitively dependent on the distance from the plasma sheet center at which the ions are created. For typical quiet-time field values we estimate energies from a few hundred eV to ~ 1 keV. The pitch angle of the particles does depend on the creation point, however, and is large (~ 90°) for ions created in the immediate vicinity of the plasma sheet center, where B_z is comparable with or larger than B_x, but is small for a majority of the ions created further away where B_x is large compared with B_z. We therefore conclude that under quiet time conditions the released lithium ions will predominantly form a field-aligned beam (~ 5° - 20° pitch angle) in the ring current region at energies ~ 1 keV. (Active experiments, convection, geomagnetic tail).

J. Geophys. Res., A, Paper 4A0487

5760 Plasma Motion, Convection, or Circulation
SUPERTHERMAL IONOSPHERIC OUTFLOWS
T. E. Moore (Space Science Laboratory, NASA Marshall Space Flight Center, Huntsville, Alabama 35812)

A review is given of the accumulating evidence that ion acceleration and heating at low altitudes play an important role in the dynamics and chemistry of the topside ionosphere and the outflow of plasma into the magnetosphere. Published fluid and kinetic descriptions of the topside ionosphere and ion exosphere provide the macroscopic context in which relevant observations are discussed. Though such models have for the most part been descriptions of regions without the strong magnetic field-aligned currents associated with ion acceleration, the observations suggest possible means of extending the models. The incorporation of transverse acceleration at low altitudes is particularly suggested, and the effects of such heating on ion chemistry are explored using a simple continuity model. One result is that the known response of the neutral atmosphere to solar activity, in the presence of transverse ion heating near 1000 km altitude, implies H+ escape at solar minimum and O+ escape at solar maximum. Increasing interest in the modeling of extreme conditions associated with high levels of geomagnetic activity and auroral processes, together with increasing availability of very low energy plasma observations, provide opportunities for fruitful interactions between theory and observation. (Superthermal, ion acceleration, polar wind).

Rev. Geophys. Space Phys., Paper 4R0937

5770 Short-period (less than 1 day) variations of magnetic field
GLOBAL COMPRESSIONAL OSCILLATIONS OF THE TERRESTRIAL MAGNETOSPHERE: THE EVIDENCE AND A MODEL
M.G. Kivelson (Dept. of Earth and Space Sciences, and Inst. of Geophysics and Planetary Physics, University of California, Los Angeles), J. Etcheto, and J.G. Trotignon

Compressional oscillations of nearly constant frequency (period ≈8 minutes) were observed from L = 5 to L = 10 near local noon over an interval of almost three hours during a dayside radial pass of the ISEE-1 spacecraft on August 12, 1982.

The density fluctuations, measured by the electron density experiment, were in phase with the compressional magnetic oscillations measured by the magnetometer. We relate the observations to an analytical model of a global compressional wave reflected at the gradient of the magnetic field and plasma density near the plasmapause and standing in the outer magnetosphere. Qualitative arguments based on the model lead one to expect that conditions in the outer magnetosphere are not normally compatible with the standing wave solution, that when such a solution can be found only the lowest eigenfrequencies will be present, and that some variation in period with local time will occur.

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